NAVSWC MP 91-805

TECHNOLOGY TRANSFER SUMMARY REPORT (FY91) NAVAL SURFACE WARFARE CENTER

BY RAMSEY D. JOHNSON
SCIENCE AND TECHNOLOGY PROGRAM OFFICE

JUNE 1992

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Dahlgren, Virginia 22448-5000 • Silver Spring, Maryland 20903-5000

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FOREWORD

This report summarizes the Naval Surface Warfare Center's (NAVSWC) participation in the following five principal areas involving technology interactions with the public and private sectors:

1. Domestic Technology Transfer (DTT)
2. Navy Potential Contractor Program (NPCP)
3. Industry Independent Research & Development (IR&D)
4. Small Business Innovation Research (SBIR)
5. Science and Technology Contracting

During the FY91 period covered by this report, NAVSWC was comprised of the Dahlgren Laboratory (DL) site at Dahlgren, Virginia and the White Oak (WO) Laboratory site in Silver Spring, Maryland. In consonance with the Navy consolidation policy, effective 1 January 1992, the Dahlgren Laboratory is now Headquarters of the Naval Surface Warfare Center Dahlgren Division (NSWCDD) with a detachment at White Oak. Also included in NSWCDD, as of 1 January 1992, is the Coastal Systems Station, formerly the Naval Coastal Systems Center (NCSC). This report does not include FY91 NCSC technology interactions.

Center technical staff members supporting science and technology and domestic technology transfer tasks contributed to the information presented in this report. Questions or requests for additional information should be referred to NAVSWC, Code D4T, Mr. Ramsey D. Johnson, (301) 394-1505 or Autovon 290-1505.

Approved by:

THOMAS A. CLARE
Technical Director

ABSTRACT

This report summarizes the Naval Surface Warfare Center's (NAVSWC) participation in the following five principal areas involving technology interactions with the public and private sectors:

1. Domestic Technology Transfer (DTT)
2. Navy Potential Contractor Program (NPCP)
3. Industry Independent Research & Development (IR&D)
4. Small Business Innovation Research (SBIR)
5. Science and Technology Contracting

CONTENTS

ILLUSTRATIONS

INTRODUCTION

The Naval Surface Warfare Center (NAVSWC) is an active participant in the following Navy and Department of Defense (DOD) programs that promote technical interactions with the private sector:

- Navy Domestic Technology Transfer (DTT)
- Navy Potential Contractor Program (NPCP)
- Industry Independent Research and Development (IR&D) Program
- Small Business Innovation Research (SBIR) Program
- Category 6.1, 6.2, and 6.3A (Science and Technology) Contracting

This report summarizes FY91 NAVSWC participation in these programs.

DOMESTIC TECHNOLOGY TRANSFER

BACKGROUND

For many years, the U.S. civilian sector has derived significant spinoff benefits from the Navy's efforts in the development and application of technology. In most cases, these transfer actions occurred on an ad hoc basis. Recognizing that the Nation would derive considerably greater benefits if DTT activity were encouraged and systematically pursued as a matter of policy, Congress passed legislation[1] to stimulate improved use of federally funded technology developments, including authority for federal laboratories to participate in cooperative research and development agreements (CRDAs) with U.S. industry and academia. To underscore this legislative interest, the President issued an Executive Order[2] calling for prompt action in implementing these initiatives for facilitating U.S. private sector access to federal science and technology. The DOD DTT Program was authorized[3] in response to the requirements of References 1 and 2.

NAVY DTT

The Navy policy of actively promoting military-civilian DTT and associated CRDAs is promulgated by directives from the Secretary of the Navy[4] and the Chief of Naval Research.[5] In this context, DTT involves the transfer of technology developed by the Navy, including inventions, software, and training technology, to the U.S. civilian sector for use in nonmilitary applications. Of course, in carrying out this policy, due care must be taken to avoid actions that might create the appearance of undue influence over, or competition with, private enterprise and the free operation of the economy. In addition, the policy must be carried out within the constraints of

proper control of classified information, military sensitive unclassified information, and militarily critical technologies.

NAVSWC PARTICIPATION

NAVSWC was participating in technology transfer activities prior to the federally enacted legislation[1] and was a charter member of the DOD Technology Transfer Consortium in 1971. This organization has subsequently evolved into the Federal Laboratory Consortium, of which NAVSWC continues to be a contributing member.

Although NAVSWC endorses and actively pursues technology transfer activities involving Center R&D efforts, significant and necessary limitations exist on the amount of NAVSWC-developed technology appropriate for transfer. With the work heavily oriented toward naval warfare applications, frequently no civilian application is apparent without extensive adaptive engineering effort. Security classification and export control of critical technologies are also significant constraints.

Public Law 99-502[1] requires that each federal laboratory either establish an Office of Research and Technology Applications (ORTA) to manage DTT activities or perform the ORTA functions within an existing organizational structure. Since NAVSWC has long maintained a DTT office, this organizational structure was unchanged following passage and implementation of Public Law 99-502. The principal elements of NAVSWC participation in DTT are described below.

PROGRAM IMPLEMENTATION

Management

The Center's domestic technology transfer policy is administered by the Science and Technology Program Office (Code D4). This office provides policy planning and guidance on technology matters impacting the role, mission, and long-term commitments of the Center. Policy implementation vehicles for technology transfer include the Center's ORTA, the Navy Potential Contractor Program, and the Federal Laboratory Consortium for Technology Transfer. The IR&D Program is also a contributor to technology transfer activities since the transfer process can involve a two-way exchange between government and nongovernment organizations. The IR&D Program serves to inform government technologists about industry-initiated research and it also serves as a mechanism for government researchers to appraise the progress and relevance of industry-initiated efforts. Guidance regarding technology transfer constraints is provided by the Militarily Critical Technologies List (MCTL), and the Center contributes to the technical review of export license applications received by the Navy International Programs Office. Technology transfer management functions include

- Managing the program within the Center
- Preparing Technology Application Assessments

- Maintaining external liaison (with the Office of the Chief of Naval Research, the Federal Laboratory Consortium for Technology Transfer, the Department of Commerce, other federal agencies, state and local governments, universities, and private industry)
- Assisting potential user organizations in formulating their problems
- Providing and disseminating information on federally owned or originated products, processes, and services having potential application to state and local governments and private industry
- Providing technical assistance in response to requests from state and local governments
- Functioning as Center manager for MCTL matters
- Serving as Center manager for review of Navy-related export license applications

The Center manager for ORTA/Technology Transfer is Mr. Ramsey D. Johnson, Code D4T, (301) 394-1505 or Autovon 290-1505.

Technical Effort

Project Work. Directly attributable and quantifiable technology transfer work performed by Center technical departments is generally represented by those projects funded by other government (nonDOD) sponsors and private parties (excluding that effort funded under DOD contracts). This type of effort, identified as project work, has manpower and funding allocations that are directed towards a specific objective or requirement per sponsor request.

Technological Disclosures. In its role as a major government R&D center, NAVSWC also serves as a significant contributor to federal technology transfer in a more generic nature via technological disclosures in the open literature such as patents, reports, journals, and participation in symposia. The benefits from this type of activity accrete as spin-offs from DOD mission-related projects that are supported by federal R&D appropriations. Although it is less tangibly measurable than technology transfer contributions of direct project work involving end-products, the long-term benefits are more highly promising since they provide the innovative community with a broad spectrum of new stimuli to promote economic, technical, and quality-of-life growth in the private and public sectors.

Navy-wide Services

The Center manages, edits, and publishes the "Navy Domestic Technology Transfer Fact Sheet." This monthly publication highlights Navy-wide technology and developments that have the appropriate approval for public release and are of potential benefit to public and private organizations, individuals, and other federal laboratories. The program is sponsored by the Office of Naval Technology (ONT-26) to provide a highly visible source and focus for the dissemination of domestic technology transfer contributions from the Navy laboratory community.

PROGRAM FUNDING

A summary of FY91 funding support for management activities and project work performed by the Center is presented below:

	FY91 ($K)
1. Administrative Functions	
ORTA Management	75
Other Technology Transfer	25
Technical Publications Division	210
2. Technical Projects	
Engineering & Information Systems Department	42
Electronics Systems Department	78
Protection Systems Department	122
Research and Technology Department	1220
Total	1672

ACCOMPLISHMENTS AND CURRENT EFFORTS SUMMARY

Project Work and Reports

Narrative summaries of NAVSWC technology transfer related projects involving FY91 effort are presented in Appendix A. The following report, which describes recent Center accomplishments, efforts, and technology transfer related resources and participation, was published for public release:

NAVSWC MP 91-142, *Technology Transfer Summary (FY90), Naval Surface Warfare Center.*

Cooperative Research and Development Agreements

As authorized by Public Law 99-502, a CRDA is any agreement between one or more federal laboratories and one or more nonfederal parties under which the participants may provide personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the missions of the participating federal laboratories. Also, the federal laboratories may receive funds from, but not provide funds to, nonfederal parties under a CRDA. Further, by statute, a CRDA is not a procurement contract or cooperative agreement as those terms are used in 31 U.S.C. 6303-6305, and the Federal Acquisition Regulation (FAR) and the DOD FAR Supplement are not applicable to these agreements.

NAVSWC has the following three active CRDAs:

- Loral Defense Systems: testing of a privately developed "Acoustic Test Vehicle"
- Ford Aerospace Corporation: battle force management software
- NEAR, Inc.: software development related to supersonic airflow

Government-Industry Conferences

These conferences provide a forum for government laboratories to inform industry participants about significant materials, processes, innovations, or developments that have promising potential for commercial application. The general format includes technical presentation sessions after which government presenters are available for individual follow-up discussions with interested industrial representatives.

DTT Awards

NAVSWC nominations to the "1991 Federal Laboratory Consortium (FLC) Award for Excellence in Technology Transfer" each received an Award of Merit. The topics were

- Development of Centrifugal Casting Process for SiC/Al Metal Matrix Composite Tubes
- Laser Heated Thermoluminescent Dosimetry Technology

Patents

As an incentive to stimulate DTT, Public Law 99-502 permits government inventors to share royalties or other income resulting from the licensing of Navy inventions. In FY91, there were 77 inventions and patent disclosures by NAVSWC with potential technology transfer applications. These are listed in Appendix B. Figure 1 shows the number of NAVSWC patents and inventions during FY86-91 that have commercial potential. Three patents have been licensed, and the NAVSWC inventors are receiving a share of the royalty income.

Navy DTT Fact Sheet

NAVSWC manages, edits, and publishes the *Navy Domestic Technology Transfer Fact Sheet.* This monthly publication highlights Navy-wide technology developments (that have been approved for public release) that are of potential benefit to public and private organizations, individuals, and other federal laboratories. The program, sponsored by the Office of Naval Technology (Code ONT-26), provides a focus and a highly visible source of information for the dissemination of DTT contributions from the Navy laboratory community. All Navy laboratories are invited to contribute articles for publication in the *Fact Sheet*, which is distributed to over 11,000 subscribers across the country. NAVSWC contributed the following articles during FY86-91:

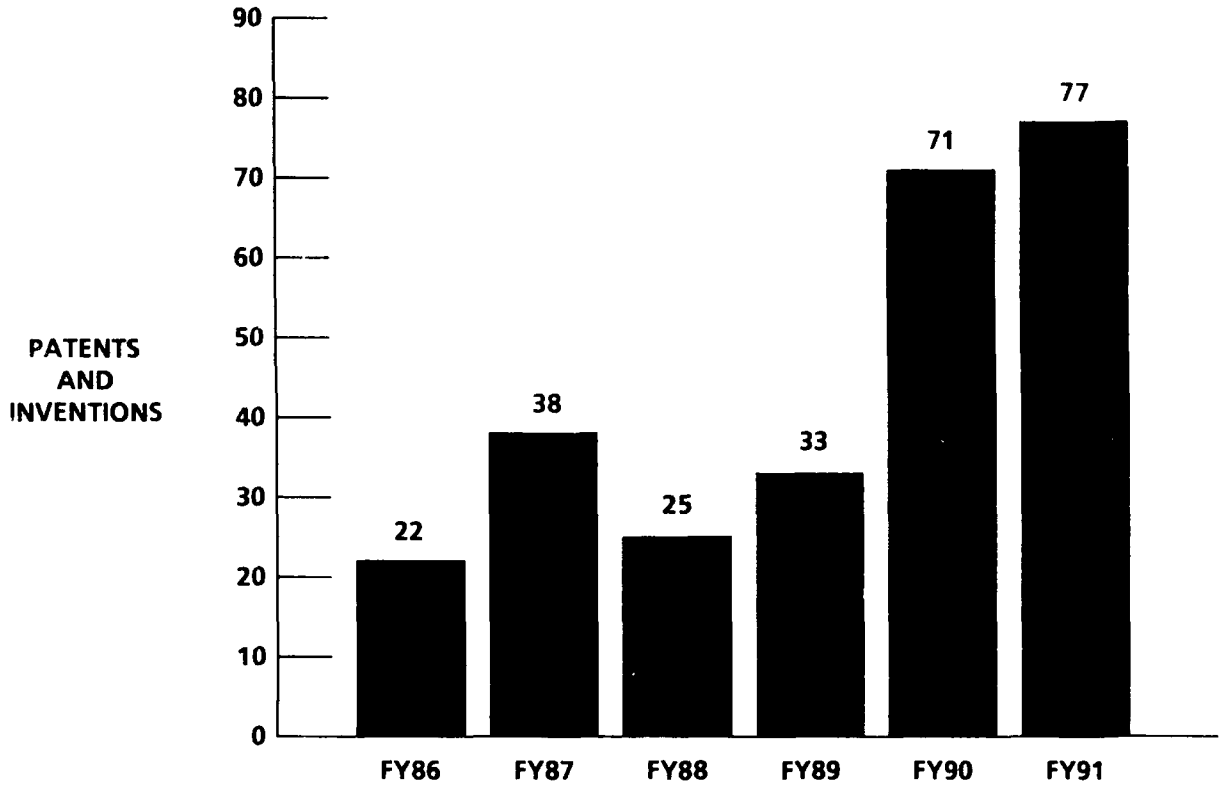


FIGURE 1. INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

FY86
- Gauge Measures High Transient Pressures
- Tool Opens Large Containers

FY87
- New Method Improves Pollution Control Devices
- Computer Software More Reliable
- Digital Dosimeter Measures Radiation Doses
- Photographic Indicator Flashes Print Status

FY88
- NSWC Develops New Electro-Mechanical Transducer
- Scientists Receive Cash Awards for Invention

FY89
- Lightweight Nickel Composite Electrode
- Data Acquisition and Reduction Processor
- New Software Tool for Navy Development
- Electronic Security Indicating Attachment Developed
- High-energy Lithium Battery

FY90
- Method for Determining the Magnitude of Earth's Gravity Developed
- Reconfigurable M-Dimensional Computer Memory Developed
- Software Package to Industry
- New Silver Oxide (AgO) Cathode Material Developed
- Freezer Alarm Developed

FY91
- Magnetoresistance Magnetometer Developed
- CRAM Developed
- Method to Identify Laser Light Sources
- Eyes Protected Against Laser Sources
- Toroidal Computer Memory Developed
- Measuring Resistivity Developed
- Kalman Filter Tracks Objects
- Technique to Measure Liquid Level & Volume Device
- Magnetic Effects Measured
- Device Developed to Inspect Materials
- "SkinHeat" Calculator Utility Program Developed
- Sensor for Electro-optic Voltage Developed

Technology Application Assessments

Public Law 99-502 requires that DTT offices prepare application assessments for selected R&D projects performed by their laboratories that may have commercial applications.

A technology application assessment (TAA) is a description of a government laboratory R&D project, process, or innovative development that is cleared for public release and has potential for alternative use in the private sector. This technical disclosure is provided to the National Technical Information Service (NTIS) and other appropriate release sources for broad dissemination in the public and private sectors. Preparation of TAAs by laboratory ORTAs is also directed by DOD 3200.12-R-4.[3] Figure 2 provides data on NAVSWC TAAs for FY83-91. FY91 items are presented in Appendix C and listed below:

- Laser Discrimination
- Optical Protection from Lasers
- Liquid Level & Volume Sensor
- Mullite Whiskers and Felt
- Electro-optic Voltage Sensor
- "SkinHeat"—Program to Calculate IR Parameters

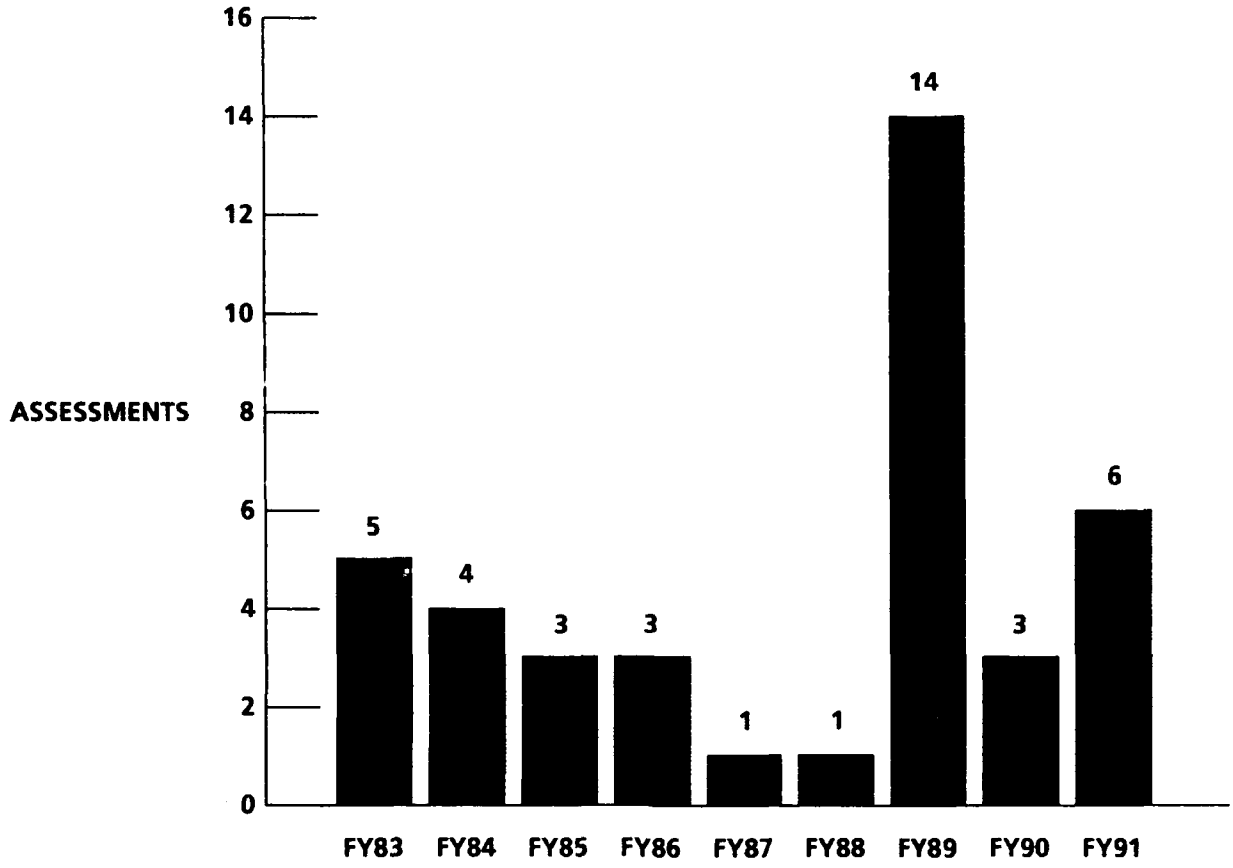


FIGURE 2. TECHNOLOGY APPLICATION ASSESSMENTS

Other DTT Disclosures/Releases

Figure 3 shows, for FY85-91, the number of NAVSWC technical publications entered in the National Technical Information Service; the number of unrestricted (public release) technical information disclosures to symposia, workshops, journals, and other publications; and the categories of responses to information requests from individuals and private industry. In FY91 the categories of responses were in the following 12 technology areas:

- Nonmetallic materials
- Electro-optics
- Software reliability analysis
- Global positioning system
- Nondestructive evaluation
- Shape-memory alloys
- Batteries
- Magnetoresistive sensors and actuators
- Metallurgy
- Target tracking
- Facilities (highway research)
- Instrumentation

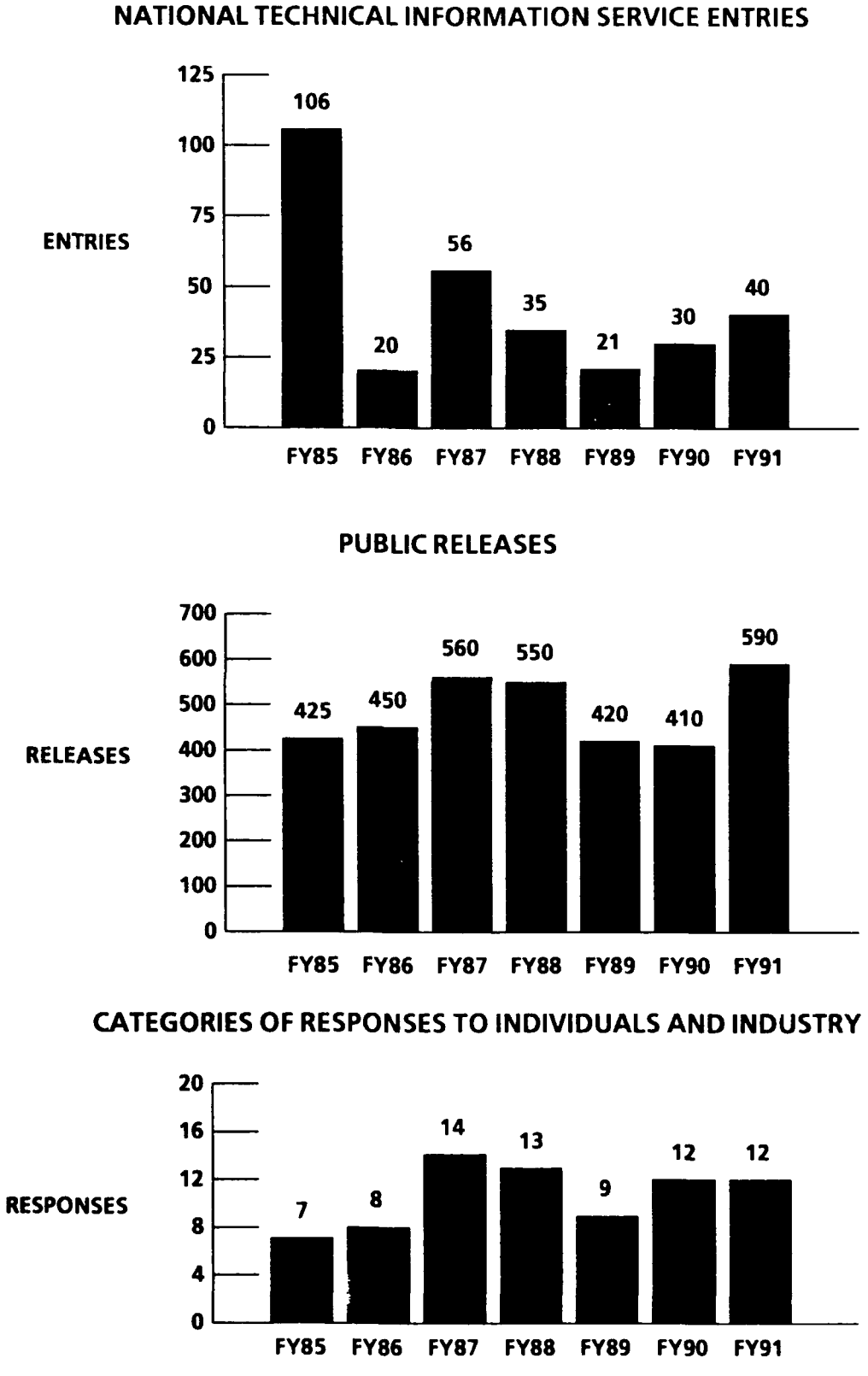


FIGURE 3. OTHER DISCLOSURES AND RELEASES

Numerous inquiries are also made directly to NAVSWC engineers and scientists in private communications; no formal records are kept of these.

Community Technical Services

NAVSWC participates in a DOD-sponsored summer Science and Engineering Apprentice Program (SEAP) for the National Capitol Area. SEAP offers paid eight-week apprenticeships for high school students interested in science and engineering. Under this program, NAVSWC hosted 94 students in 1991 who pursued scientific experiences with staff scientists or engineers who served as mentors.

Local high schools, middle schools, and elementary schools benefit from tutorial activities provided by NAVSWC volunteers. Participation includes classroom lectures, individual tutoring, and Science Fair judging.

NAVY POTENTIAL CONTRACTOR PROGRAM

If technological developments are to be applied promptly to meeting Navy requirements, it is essential that the scientific and technical community have appropriate access to technical information about those requirements.

Some requirement information is conveyed to scientists and engineers by briefings, symposia, and site visits. However, there are problems inherent to the process that may preclude information from reaching those who may be able to solve Navy technical problems. They include

- Lack of access to information required to prepare timely and technically relevant contract proposals by qualified civilian groups that do not hold a contract
- Lack of access by holders of current contracts to classified or military critical unclassified information in areas not concerning their contracts (those data could assist them in developing alternate solutions and in planning and executing their IR&D programs)
- Lack of orientation concerning the operational environment and probable conditions in which Navy equipment must function
- Prevention of the compromise of sensitive information while ensuring that it reaches those who have a valid "need to know"

NAVY POLICY

The Navy recognizes the need to facilitate the increased use of civilian sector technological investments in meeting military requirements. That will best be accomplished by providing civilian scientists with increased, appropriate access to defense technological data. Accordingly, the NPCP is being established to provide controlled access to relevant military data by the civilian scientific and technical sector. The NPCP wil also allow use of civilian discretionary funds to address Navy

needs. Navy activities are to encourage U.S. qualified firms, academia, other organizations, and individuals to participate in the NPCP. That includes U.S. firms under foreign ownership, control, or influence if the foreign interest risk is managed in accordance with the Industrial Security Regulation.[6]

The NPCP permits no-cost negotiated agreements that authorize access to information for specified purposes. Such agreements are not government procurement contracts, grant agreements, or cooperative agreements as defined in sections 6303, 630, and 6305 of U.S.C., Title 31.[7] Agreements allow access to information only, and neither party is permitted to require delivery of technical goods or services as condition for NPCP participation.

NAVSWC PARTICIPATION

Figure 4 shows the number of NPCP agreements that NAVSWC has entered into during the FY86-91 period. The agreement titles and names of the nongovernment participants for FY91 are listed below:

Company	Agreement Title
Vitro Corp.	NATO AAW Systems Dev.
SAIC	Stratplan 2010
Loral Aerospace	Investigation of the Effectiveness of Lightweight EO Systems
AdTech	Stratplan 2010
General Electric	AEGIS Spy Radar Support
Martin Marietta	EO Tracking Systems
SysExplorations	Naval Space Tactical Awareness Brief
Loral Defense	Advanced Mine Systems
ASW Tech Center	Acoustic Detection
Rockwell International	Stratplan 2010
Directed Tech.	Airborne/Air-augmented ATBM Systems
Unisys	Quick Reaction Combat Systems Integration
Bath Iron Works	Stratplan 2010
Hughes Aircraft	Underwater Mines
Vitro Corp.	Multiwarfare Systems Effectiveness
Vitro Corp.	Electro-optical/Optoelectronic Devices
Starmark Corp.	Stratplan 2010

Company	Agreement Title
Maxwell Labs	Pulsed Electric Power
Hughes Aircraft	Stratplan 2010
D. R. Kennedy & Assoc.	Enhanced Performance Nonnuclear Warhead Concepts
Grumman Aerospace	Stratplan 2010
Teledyne Brown	Stratplan 2010

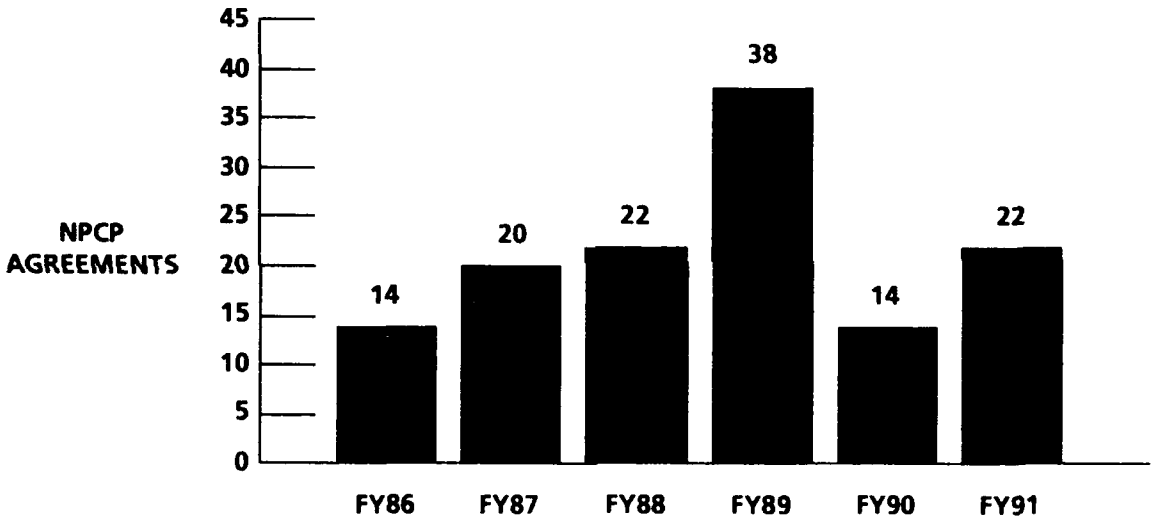


FIGURE 4. NAVY POTENTIAL CONTRACTOR PROGRAM AGREEMENTS

INDUSTRY INDEPENDENT RESEARCH AND DEVELOPMENT

IR&D is the technical effort conducted by private companies for their own business purposes; it is not sponsored by, or required in performance of, a contract or grant. IR&D represents a significant portion (about $5B annually) of the Nation's technology base; thus, the government has an interest in encouraging its coordination with other technology efforts. To encourage industry to maintain a strong IR&D effort, the government allows an average of 40 percent of the cost to be applied to overhead rates.

The potential benefits to the Navy and Marine Corps from close coordination of industry IR&D efforts with Navy research, development, test, and evaluation (RDT&E) programs are significant and range from exchanges of technology to development of cooperative R&D efforts with industry. To ensure that these benefits are fully realized, Navy and Marine Corps managers must be cognizant of relevant IR&D projects to exploit the associated results. Accordingly, the Navy has established a program to ensure the timely acquisition, dissemination, and application of IR&D information and to provide information to industry on Navy, Marine Corps, and DOD technology requirements and programs. Figure 5 summarizes NAVSWC support of industry IR&D for FY86-91.

To maintain its technological advantage and to ensure effective future defense capabilities, the DOD must aggressively employ all resources, including the IR&D programs of American industry, that can contribute to the development of future weapons systems. Specifically, the IR&D programs of DOD contractors will be thoroughly reviewed and evaluated for applicability to current and future Navy and Marine Corps needs as well as for technical quality. Because of the importance of IR&D to the Navy, the Navy will

- Make maximum use of industry programs by integrating them with Navy program plans
- Make industry aware of the military threat, requirements, and problems facing the Navy and Marine Corps so that industry can plan and carry out IR&D that fills Navy and Marine Corps needs
- Encourage basic research and innovative work in the programs of DOD contractors (this includes encouragement of industry contracts to academic institutions for basic research that supports the contractor's IR&D program)
- Recognize that the review and evaluation of DOD contractor IR&D programs is a valuable part of Navy RDT&E (the review process keeps the Navy abreast of technological advances, and the resulting feedback to the contractors ensures that the IR&D program is kept aligned with significant military needs)
- Give management attention and support to the IR&D review and evaluation process by providing qualified, credible, high-level evaluators; ensure that evaluations are timely and thorough; and give official recognition and credit to the evaluators

SMALL BUSINESS INNOVATION RESEARCH

BACKGROUND

The SBIR program is mandated by Public Law.[8,9] The basic design of the DOD SBIR program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive of June 1988. DOD components invite small business firms to submit proposals under an annual solicitation entitled SBIR. Firms with strong R&D capabilities in science or engineering in any of the topic areas presented are encouraged to participate. Subject to availability of funds, DOD components will

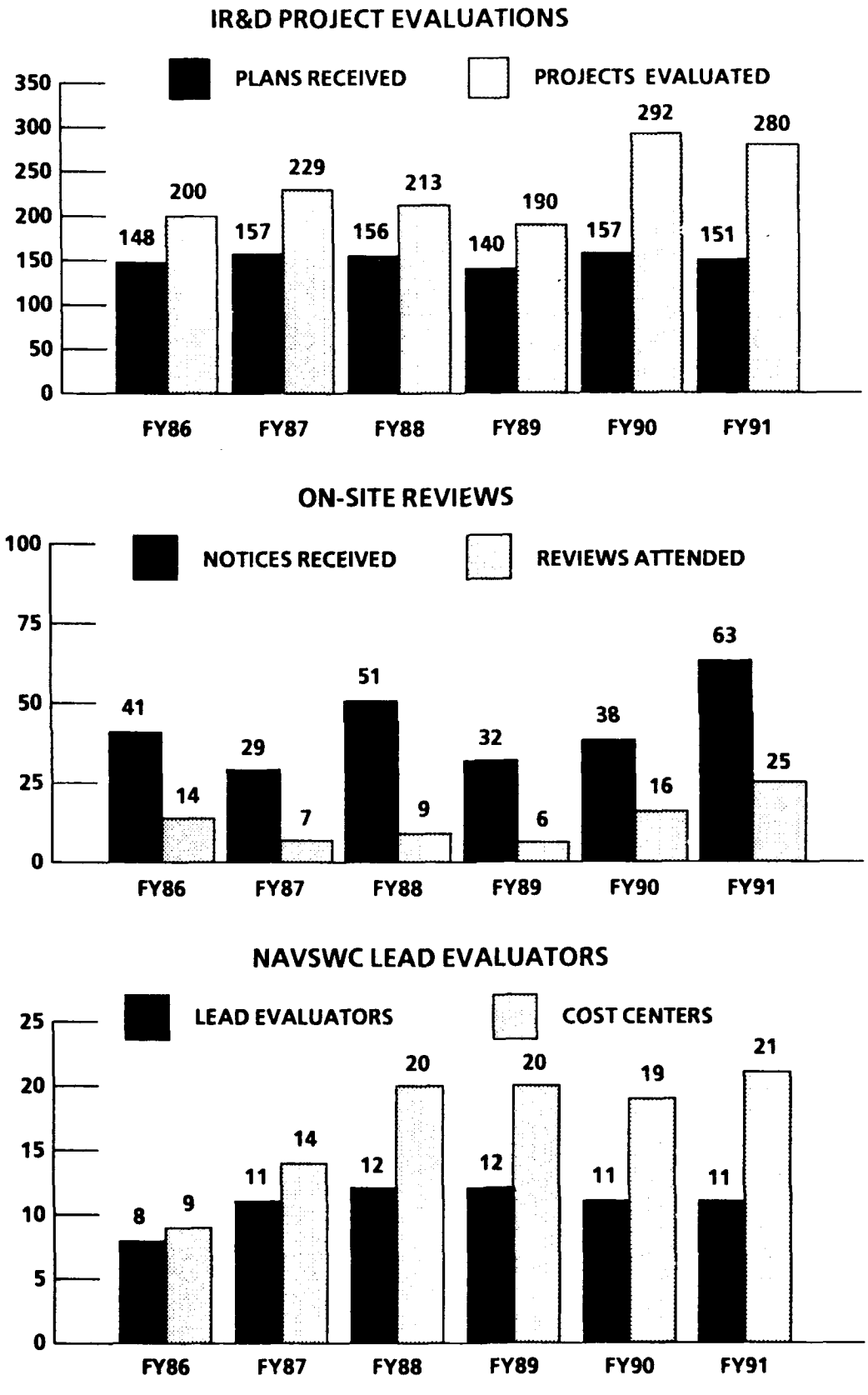


FIGURE 5. INDUSTRY INDEPENDENT RESEARCH AND DEVELOPMENT

support high-quality research or R&D proposals of innovative concepts to solve the listed defense-related scientific or engineering problems.

Objectives of the DOD SBIR program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD R&D needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or R&D results. Recent NAVSWC SBIR participation is summarized in Figure 6.

The annual DOD program solicitation strives to encourage scientific and technical innovation in areas specifically identified by DOD components. Guidance incorporates and exploits the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD.

THREE-PHASE PROGRAM

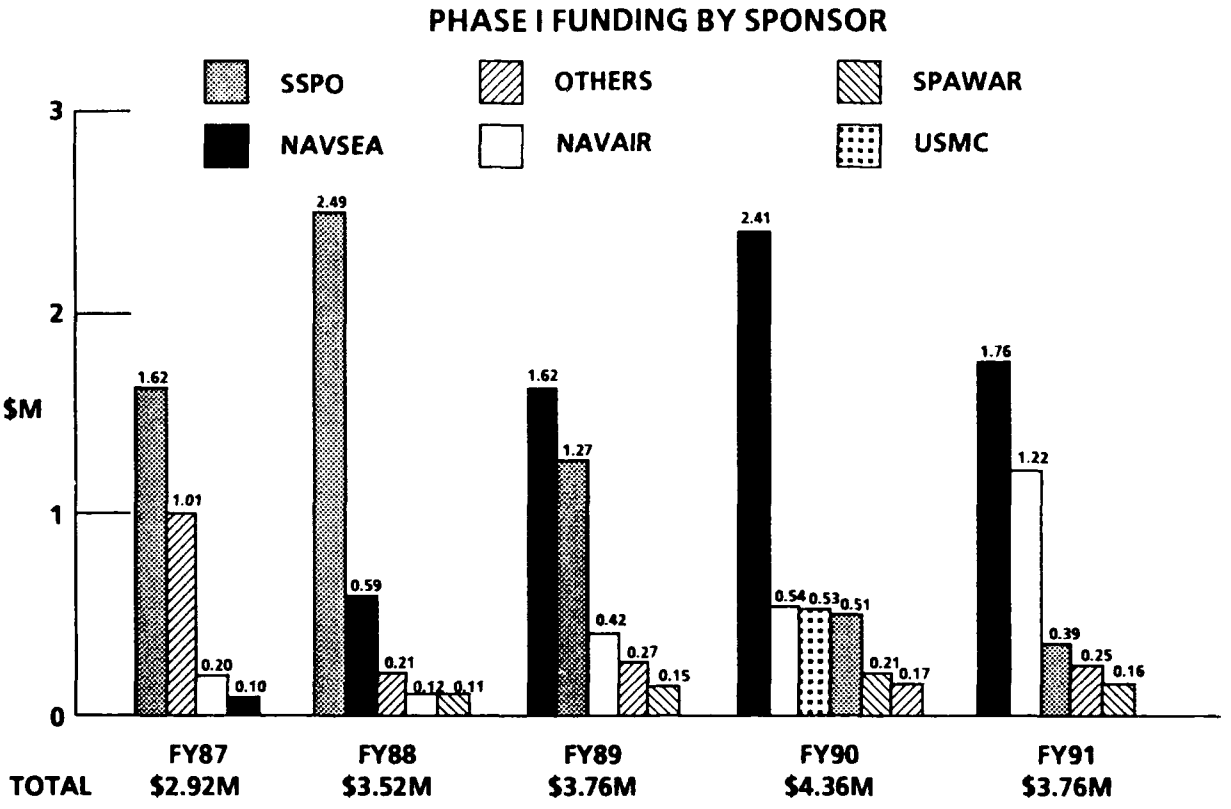
Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program. Typically, it involves about half a man-year of effort over a period of 6 months or less. Proposals should concentrate on efforts that will significantly contribute to establishing the feasibility of the proposed effort. Successful completion of those efforts is a prerequisite for further DOD support in Phase II.

Phase II awards will be made to firms only on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 man-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or R&D effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal is required for Phase II.

Under Phase III, nonfederal capital is expected to be used by the small business to pursue commercial applications of the research or development. Under Phase III, federal agencies may also award non-SBIR-funded follow-on contracts for products or processes that meet the mission needs of those agencies. The solicitation is designed in part to provide incentives for the conversion of federally-sponsored R&D innovation in the private sector. The federal R&D can serve as both a technical and preventure capital base for ideas that may have commercial potential.

SCIENCE AND TECHNOLOGY CONTRACTING

In addition to the cooperative efforts with industry described above, NAVSWC participates even more directly, in a major way, with industry by contracting out roughly half of its total science and technology funding. Through these mutually beneficial contracts, the Navy is able to apply the talents and facilities of industry to the achievement of its technology objectives.



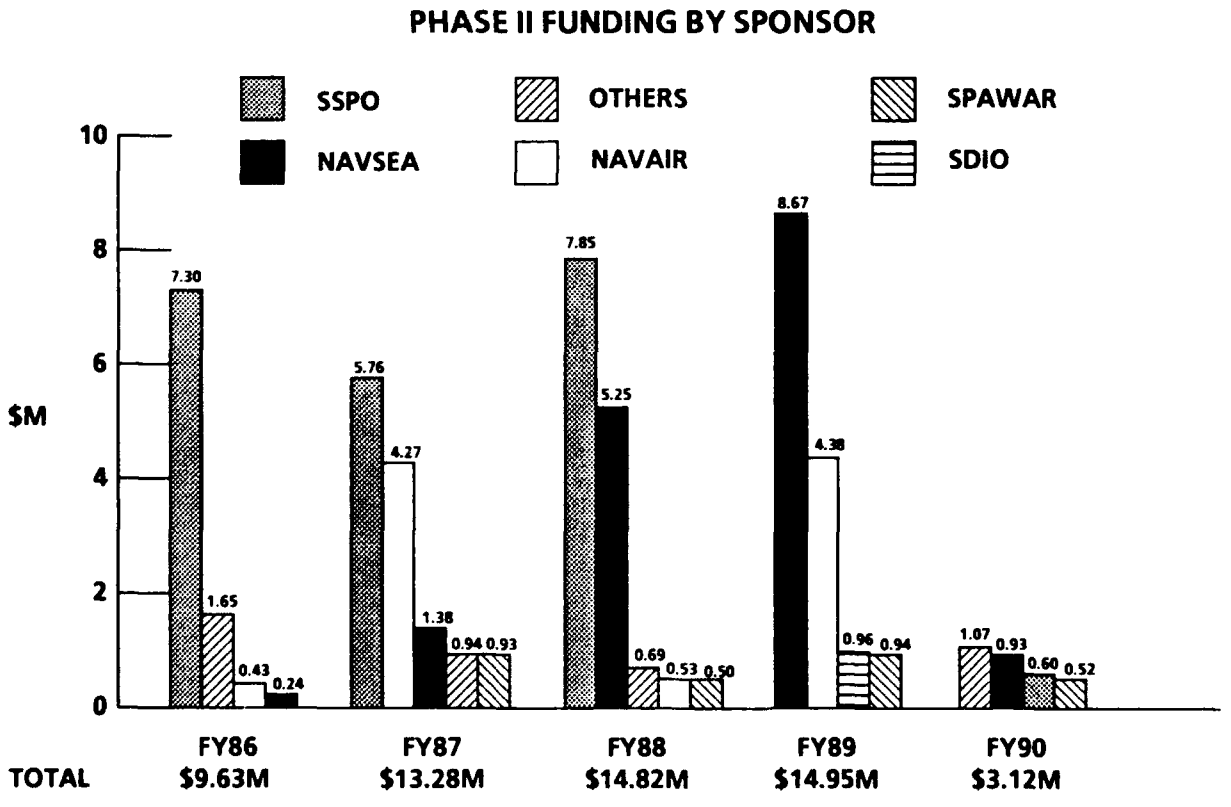


FIGURE 6. SMALL BUSINESS INNOVATION RESEARCH

Science and technology funding consists of the following Category 6 funding appropriations:

- 6.1: Research
- 6.2: Exploratory Development
- 6.3A: Advanced Technology Development

Figure 7 shows a breakout of NAVSWC in-house and contracted science and technology funding for FY89-91 expenditures.

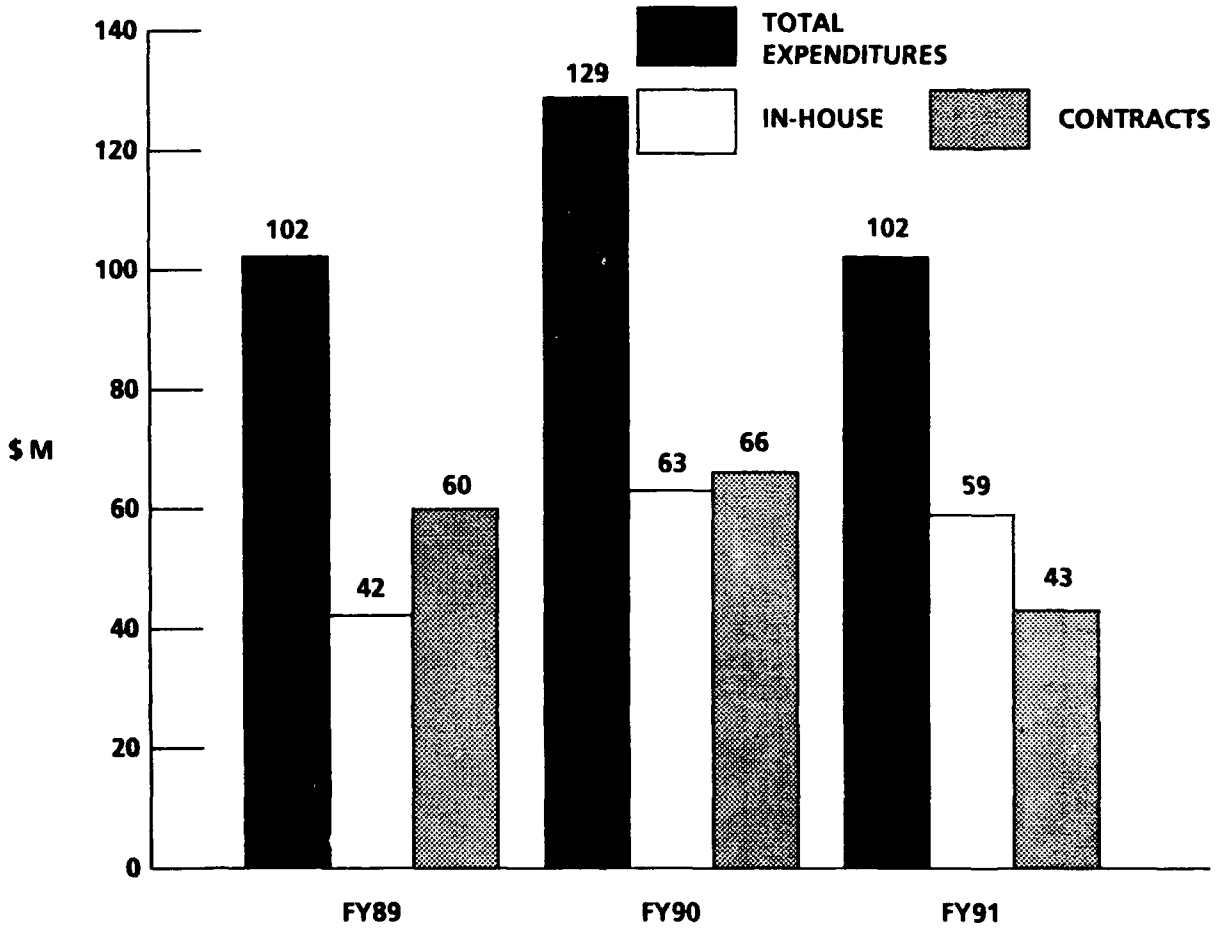


FIGURE 7. SCIENCE AND TECHNOLOGY EXPENDITURES

REFERENCES

1. Public Law 96-480, "Stevenson-Wydler Technology Innovation Act of 1980," 21 October 1980, as amended by Public Law 99-502, "Federal Technology Transfer Act of 1986," 20 Oct 1986.

2. Executive Order 12591, "Facilitating Access to Science and Technology," 10 Apr 1987.

3. DOD 3200.12-R-4, "Domestic Technology Transfer Program Regulation," 27 Dec 1988.

4. SECNAVINST 5700.16, "Domestic Technology Transfer."

5 OCNRINST 5700.1, "Navy Domestic Technology Transfer Program."

6. DOD 5220.22-R of Dec 1985, "Industrial Security Regulation."

7. U.S.C., Title 31, "Money & Finance: Treasury."

8. Public Law 97-219, "Small Business Innovation Development Act of 1982."

9. Public Law 99-443, "Small Business Innovation Research Program Extension."

APPENDIX A

NARRATIVE SUMMARIES FOR NAVSWC FY91 TECHNOLOGY TRANSFER RELATED PROJECTS

MANUFACTURING TECHNOLOGY

The Navy Manufacturing Technology Program requires that technology transfer to the private sector and government agencies be a major activity of each funded project. Accordingly, upon completion each project is required to have an end-of-project demonstration for potential users or vendors and to issue a final report. In both instances, efforts are made to disseminate the information to the widest possible audience. However, while some of the information is classified and some is unclassified, all is associated with critical, sensitive technologies. This information is not releasable for public information and such requests are individually assessed based on distribution restrictions. Each project manager is encouraged to actively communicate with interested parties during the project to transfer the developing technology.

In addition to technical project work, the Naval Surface Warfare Center (NAVSWC) also provides technical and administrative program support to the Office of Naval Acquisition Support; the Naval Sea Systems Command; and the Office of the Assistant Secretary of the Navy, Shipbuilding and Logistics (OASN, S&L) for manufacturing technology programs.

The following Manufacturing Technology projects are active at NAVSWC:

- Cast Projectile Program
- Spin Form Discontinuous Metal Matrix Composites (MMCs)
- Composites for Passive Thermal Management

FAA BLAST LOADING PROGRAM

After the Pan Am 103 bombing, the Federal Aviation Administration (FAA) undertook a program to develop hardening techniques for commercial aircraft. As a part of this effort, the Explosion Dynamics Branch was tasked to provide the blast loads produced by small explosions (explosive weight less than 3 lb) inside suitcases. A series of tests was conducted with explosive weights of 1.5 and 3.0 lb. The test included the effects of multiple suitcases—up to a series of final tests with 80 suitcases inside an LD3 baggage container. The data form a predictive data base. In addition, the data were used to validate the computer code INBLAST, which can now be used to make the loading predictions.

NASA/MARSHALL SPACE FLIGHT CENTER SUPPORT

1. Solid Propellant Initiative Program (SPIP) support. Conduct an advanced nozzle cements and adhesives study to assist the National Aeronautics and Space Administration (NASA) in determining those commercially available rocket nozzle cements best suited for bonding various parts of rocket nozzles such that they will survive the intended mission. Major tasks of the study are to determine the bond strength and characteristic yield of the cement after its major decomposition together with its gas evolution.

- Complete the chemical and thermal characterization of UCAR C-34 and Dylon GC cements and publish results.

- Acquire and characterize other available advanced cements.

2. Carbon-carbon Manufacturing Process. Investigate the applicability of using the eddy current nondestructive test technique to evaluate carbon-carbon composite materials throughout the manufacturing process.

- Evaluate nozzle components and material samples that contain wrinkles and other defects. Detect and measure localized anomalies.
- Specify bulk conductivity measurements to assure proper manufacturing processes including the isolation of matrix and fiber contributions to the conductivity.
- Optimize eddy current probe designs for each specific material and task.

3. Ultrasonic Assessment of Large Solid Rocket Motor Bondline Integrity. Determine the integrity of bondlines in large solid rocket motors using Time Delay Spectroscopy (TDS).

- Obtain TDS equipment and analyze TDS data on simulated rocket motor sections.
- Specify the components of a TDS inspection system suitable for incorporating into a practical field inspection system.
- Measure the ultrasonic velocity and attenuation of propellants and other solid rocket motor materials.
- Assist with the transition of the Acoustic Emission technique for test monitoring.
- Provide NASA/Marshall program management with an independent assessment of the technical aspects of the program related to non-destructive testing.

4. Characterization of Bondline Mechanical Performance. Support NASA in developing a methodology for accurate and reliable characterization of bondline performance via chemical and mechanical testing and analysis of bondline specimens.

- Conduct experiments to characterize bondlines in terms of constituents, bond-in-tension specimen testing, and dewetting parameters.
- Continue efforts on constitutive model development and conduct chemistry studies of gradient properties at or near bondlines, along with combustion studies of strained propellant specimens in the bondline region.
- Work with the Structures and Mechanical Behavior Subcommittee (S&MBS) of JANMAF and represent NASA SPIP in the development of bondline test specimen standards.

SPACE SHUTTLE STUDY

In FY89, NAVSWC completed a study for NASA (Marshall Space Flight Center) to determine the complete break-up process of the Space Shuttle's solid rocket boosters (SRBs) in a "command destruct," and further, to determine whether the process would also destroy the external tank (ET). This information was necessary to support a decision regarding the necessity of retaining the ET Range Safety System (RSS).

As an outgrowth of this research, NAVSWC proposed a modification to the current design of an axially running linear shaped charge. The potential advantages of the proposed redesign include dramatic decrease in SRB fragmentation, decreased risk of breaching the containment vessel for nuclear powered payloads, and the capability to destroy the liquid oxygen (LOX) and liquid hydrogen (LH_2) tanks from the destruct of one SRB with the ET RSS inactive. The redesign effort was funded beginning in FY89 and was completed in FY90. However, the costs associated with a full-scale demonstration test program required by the Air Force Eastern Space and Missile Center led NASA to an eventual decision to retain the current RSS. Final reporting was completed in FY91.

NIGHT VISION EQUIPMENT

In support of the U.S. Border Patrol (USBP) of the Immigration and Naturalization Service, NAVSWC provided technical assistance and expertise for the repair and upgrade of night vision equipment owned by the USBP. This equipment is used by the USBP in the protection of U.S. land and water boundaries against illegal entry of aliens, drugs, and other contraband.

SHOCK AND VIBRATION INFORMATION ANALYSIS CENTER

The Shock and Vibration Information Analysis Center (SAVIAC) is an interagency effort chartered to provide a clearinghouse to analyze and exchange technical information in the technical specialty area of shock and vibration. Oversight of SAVIAC is provided by an interagency Technical Advisory Group (TAG) that was initially chaired by NAVSWC. Members from the Army, the Air Force, the Navy, the Defense Nuclear Agency, the Department of Energy, and NASA comprise the TAG. This cooperative effort at information collection, distribution, analysis, and exchange is an important tool in addressing survivability and protection issues and problems encountered in operational environments. SAVIAC can be used by any of the sponsoring agencies and their contractors. It is on-line to provide special analysis and technical evaluation studies for specific problems raised in research and development (R&D) programs and other efforts.

DEPARTMENT OF TRANSPORTATION (COAST GUARD) SUPPORT

1. A performance specification was developed for a mid-band infrared imaging system to be used for the recognition, characterization, and identification of vessels at sea. An analysis of the system sensor requirements was performed in conjunction with this task. NAVSWC also conducted an electromagnetic interference (EMI) assessment and recommended specifications to protect the system from degraded performance and damage due to EMI.

2. The following weapons system safety support was provided for the Hamilton class and Bear class Coast Guard cutters:

- Design of firing cut-out cams for the Mk 75 and CIWS weapons
- Fabrication of cut-out cams
- Verification and certification of safety zones

DEPARTMENT OF TRANSPORTATION/FHWA

1. Under previous Federal Highway Administration (FHWA) sponsorship, NAVSWC has developed a prototype battery-operated motor vehicle detection system. This Self-Powered Vehicle Detector (SPVD) may be buried in any type of road surface and uses radio frequency (RF) transmission rather than hardwiring for communication with its control unit. The detector reads a vehicle's magnetic signature, processes it, and transmits the vehicle's presence to the remotely located control unit. Details of this device are provided in NAVSWC Technology Application Assessment NSWC-TAA-85-002.

2. In FY91, NAVSWC provided design consultation for pre-production SPVD units being manufactured by private industry under FHWA contract.

TEST FACILITIES

NAVSWC has developed unique capabilities and facilities for conducting electromagnetic vulnerability tests. These specialized facilities are available to both Department of Defense (DOD) and civilian organizations. Recently, the facilities were used to certify the Boeing 747-400.

NASA/LANGLEY RESEARCH CENTER SUPPORT

In FY91, NAVSWC initiated a preliminary study for NASA (Langley Research Center) to determine what effect, if any, thermal aging had on the "swage area" of a 21/2 grain per foot shielded mild detonating cord (SMDC) containing DIPAM and HNS as the energetic core materials. This preliminary information was necessary to support a decision regarding the necessity of funding a comprehensive study in FY92.

EXPLOSIVE TECHNOLOGY

Explosives Technology (ET) of Fairfield, California, requested NAVSWC support to conduct a quantitative chemical and moisture analysis on several samples of DIPAM 21/2 grain per foot SMDC to determine if either of these conditions (impure material and/or high moisture content) could be responsible for line failures. The data reported to ET indicated that neither of these conditions could be attributed to the analyzed samples.

LASER WELDING FOR ROCKET MOTORS

NAVSWC and a private company participated in a study in FY90 to investigate a laser welding manufacturing procedure for steel rocket motor cases (RMCs). The

principal test parameter was to hold the back wall temperature to less than 250°F (for potential live RMC applications). Laser parameters were developed and the technique was applied to steel RMC cylinders (mock-ups) and an all-up RMC simulator that was ablatively lined. Initial tests met the temperature requirement, but the organic ablative/adhesive appeared to contaminate the weld of the ablatively lined case. Reporting was completed in FY91.

TOURMALINE GAUGES

The original tourmaline gauge was designed and developed under Navy contract at Woods Hole Oceanographic Institute during World War II. These gauges are used to measure shockwave phenomena from underwater explosions. After the war, scientists formed Crystal Research Company to market the gauge; the company closed in 1972. NAVSWC purchased the company assets and began producing gauges to fill the void left by the defunct company. Improvements have been made to the gauges in relation to evolving technology.

NAVSWC constructs and calibrates the gauges, which are sold at fixed price to various Government and industry research activities. Gauges and related information are exchanged with foreign governments with whom the U. S. has information exchange agreements. The following have purchased gauges in FY91:

- Elda Trading Corporation/New York
- Ballistech Systems, Incorporated/Quebec
- National Defense Research Establishment/Sweden

NASA/GODDARD SPACE FLIGHT CENTER SUPPORT

NAVSWC inspected and performed nondestructive evaluation on trunnions used to hold cargo in the cargo bay of the space shuttle. Eddy current and ultrasonic methods were employed to determine the soundness of the hardware items.

SYSTEMS RESEARCH CENTER AT VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY (VPI&SU)

In 1983, NAVSWC, the Naval Sea Systems Command (NAVSEA), Combat Systems Directorate (SEA-06), and VPI&SU established the Systems Research Center (SRC) at the University. The SRC is intended to augment the technology base of NAVSWC in serving the R&D needs of surface combat systems, recognizing that the benefits derived can extend to subsurface and air platforms as well. The SRC has also expanded the technology base for other U. S. Navy R&D activities serving R&D needs of surface combat systems. The SRC, NAVSWC, and NAVSEA's (SEA-06) joint effort emphasizes computer science and computing technology, key elements in modern naval applications. The SRC was established to perform only R&D.

By the close of FY89, the SRC had received nearly $4.52 million to perform 41 separate tasks. In FY89, there were 10 active tasks with the SRC. Of these, 5 began in FY88 and 5 in FY89. Of the 10 projects, NAVSWC sponsored 9 at a cost of over $764K.

In late September 1989, an Indefinite Delivery Indefinite Quantity (IDIQ) contract was signed with VPI. The contract calls for performance from 30 September 1989 through 30 September 1994. The IDIQ contract has a potential value of nearly $7.78 million if fully funded. As of January 1992, 12 delivery orders valued at $1,091,808 have been initiated under the IDIQ.

COMPUTER SCIENCE RESOURCES CONSORTIUM

The Computer Science Department at VPI&SU has established a Computer Science Resources Consortium (CSRC) program with the goal to strengthen existing interactions and to create new interactions between VPI&SU professors, the government, and the industry technical community. NAVSWC has been an associate member of this Consortium since 1984 and has provided a representative for the CSRC Steering Committee during that time. NAVSWC became a full member in 1990.

Mutual benefits of the program include

- Providing a resource of quality graduates to academia, industry, and government
- Promoting government/academia personnel exchanges
- Providing feedback for orienting teaching requirements toward real-life applications
- Providing an increased awareness of outside requirements to focus academic research efforts

During 1991, the Consortium sponsored the following events that promoted technology transfers:

- A semiannual newsletter featuring articles on current research activities
- A catalog of technical reports from the VPI&SU Computer Science Department
- A publication "Great Companies to Work For," 1990-1991, containing profiles of 15 organizations, among them NAVSWC
- A Student Profile Catalog, 1991-1992, containing resumes of a large number of undergraduate and graduate students
- The Annual Virginia Computer Users Conference combined with the Annual CSRC Steering Committee meeting

APPENDIX B
NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Metal composites	73,171	Microstructurally Toughened Articles & Casting Thereof	Metal composite tubes, pipes, and other structural articles
Ceramic/metal composites	73,301	Silver-Lined Ceramic Vessel & Method of Preparation	Reaction vessels for making high-temperature superconducting ceramics and other materials
Explosives	70,999	Flexible Sheet Explosive	Demolition, metal cladding processes
Superconductors	73,110	Silver Method for Producing Coated Superconducting Ceramic Powder	Producing high-temperature superconducting materials capable of being forged, swaged, drawn, etc. into wires, cables, and other structures
Metal matrix composites	73,383	Metal Matrices Reinforced with Silver-Coated Boron Carbide Particles	High-strength, lightweight structural materials—useful in aerospace
Carbon-carbon and metal matrix composites	71,947	Method of Bonding Carbon-Carbon and Metal Matrix Composite Structures	Joining carbon-carbon composite and metal matrix composite pieces by diffusion bonding
Batteries	73,723	Lightweight Battery Electrode and Method of Making It	Lightweight cadmium/cadmium oxide and nickel/nickel oxide electrodes and a process for making them
Electronic radiant energy generation	73,010	Microchannel Electron Source	(TV type) Cathode ray tubes and microwave tubes for radar systems, etc.—wide variety of electronic installations
Radar	72,700	Impulse Transmitter and Quantum Detection Radar System	Radar monitoring systems in general
Electronic optical tracking	72,629	Optical Tracking of Charged Particle Beams	Measurement of atmospheric emissions for pollution control

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL (CONTINUED)

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Radiation frequency conversion	73,226	Graded Bandgap Semiconductor Device for Real-Time Imaging	Night vision instrumentation, infrared radiation generation, graded bandgap semiconductor construction
Electronic data collection	73,040	Material Characterizing System	Electronic determination of mechanical properties of materials
Metal/ceramic composites	73,109	Silver-Coated Superconducting Ceramic Powder	Formation of superconducting material
Electrical power	72,851	Power Terminal Protection Device	Protection against high electrical voltages in general
Turbojet engines	72,905	Underwater Turbojet Engine	Underwater propulsion
Plasma generation	73,297	Steady-State, High-Dose Neutron Generation and Concentration Apparatus and Method	Neutron source for radiography
3-D imaging	73,412	Three-Dimensional Range Imaging System	3-D photography
Deuterium enrichment	73,550	Concentration of Isotopic Hydrogen by Temperature Gradient Effect in Soluble Metal	Power source
Booster rockets	73,584	Booster Rocket Range Safety System	Space propulsion
Air purification	73,586	Large-Scale Purification of Contaminated Air	Air pollution control
Particle beam acceleration	73,721	Electron Acceleration System	Electron beam accelerators
Data processing hardware	73,769	Cable Connector/Adapter Support for Multi-Terminal Data Processors	Multicable computer installations

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Computer memory	73,181	Crosstie Random Access Memory Element and a Process for the Fabrication Thereof	Computer hardware
Computer memory	73,182	Block Line Memory Element and Ram Memory	Computer hardware
Computer memory circuitry	73,190	Crosstie Random Access Memory Element Having Associated Read/Write Circuitry	Computer hardware
Computer memory circuitry	73,191	Crosstie Random Access Memory Element Having Associated Read/Write Circuitry	Computer hardware
Diamond films and composites	73,416	Method of Joining Diamond Structures	Bonding diamond structural pieces together
Carbon/carbon composites	5,051,307	Process for Producing Uniform Protective Coatings of Silver Metal on Carbon/Carbon Composites	Aerospace, satellite structural materials
Batteries	5,045,349	Silver-Nickel Composite Cathodes for Alkaline Secondary Batteries	Lightweight batteries
Ceramics	5,041,400	Low-Temperature Synthesis of High-Purity Monoclinic Celsian	Radomes Electronic substrates
Metal matrix composites	5,025,849	Centrifugal Casting of Composite	Metal matrix composite tubes and pipes
Metallurgy	4,978,054	Diffusion Bonding Process for Aluminum and Aluminum Alloys	In super plastic processes for producing complex aluminum alloy shapes, the need for welding or riveting together is eliminated

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Superconductors	4,988,673	Method for Producing Silver-Coated Superconducting Ceramic Powder	Coating high-temperature ceramic superconductor with silver for use in producing wires and other structures
Ceramics	4,994,419	Low-Temperature Synthesis of High-Purity Monoclinic Celsian Using Topaz	Electronic substrates Radomes
Propulsion	5,010,804	Launching Projectiles with Hydrogen Gas Generated from Titanium-Water Reactions	Space application, electromagnetic guns
Optical processing	4,990,762	Laser Beam Phase Measurement and Control System	Optical scanning
Robots	4,991,509	Optical Proximity Detector	Optical proximity detecting device for robot
Explosive tool	5,010,823	Linear Propelling Separator	Tool for explosively cutting a body and separating the cut bodies
Magnetic field measurement	5,038,103	Optical Fiber Magnetometer	Vehicle traffic density measurement and control
Superconducting material	5,047,387	Method for Selecting Superconducting Powders	A process for beneficiation of super-conducting powders
Sonar	4,975,887	Bistatic Side-Scan Sonar	Improved side-scan sonar to locating objects on ocean floor
Magnetostriction	73,039	Magnetostrictive Motor System	Electric motor drives
Semiconductors	73,170	Method of Doping Single Crystal Diamond for Electronic Devices	Integrated electronic circuits semi-conductors
Detector	4,996,579	Design for Electronic Spectrally Tunable Infrared Detector	Potential use for detecting poison chemical substrates in air

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Logic voltage level conversion	4,975,602	Logic Level Data Conversion System	Computer hardware
Material testing	4,979,396	Fatigue Testing Apparatus	Wire testing
Acoustical energy propagation	4,991,149	Underwater Object Detection System	Underwater exploration
Optical fiber	4,996,692	Laser Communication System with Wide-Band Magnetostrictive Modulation	Communications
Dosimeters	5,003,180	Method of Recycling Dosimeters	Radiation dose monitoring
Computer memories	4,962,477	Enhanced Crosstie Random Access Memory Element and Process for the Fabrication Thereof	Computer hardware
Magnetostriction	5,039,894	Magnetostrictive Linear Motor	Electric motors
Plasma	5,051,659	Bulk Plasma Generation	Plasma generation
Photovoltaic semiconductors	5,047,622	Long Wavelength Infrared Detector with Heterojunction	Radiation detection
Photovoltaic semiconductors	5,012,083	Long Wavelength Infrared Detector with Heterojunction	Radiation detection
Stimulated photo-luminescence	5,045,707	Laser Detection and Discrimination System	Radiation detection
Magnetostriction	5,041,753	High Torque Magnetic Angular Positioning Motor	Electric motors

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Heat energy conversion	5,003,779	Geothermal Energy Conversion System	Extraction of geothermal energy
Heat energy conversion	4,996,842	Geothermal Energy Conversion System	Extraction of geothermal energy
Aerodynamics	5,014,932	Window Cooling for High-Speed Flight	High-speed aircraft
Diamond structures	73,414	Consolidation of Diamond-Packed Powders	Method of producing radomes or other complex-shaped diamond structures
Production of hydrogen gas	73,499	Material and Method for Fast Generation of Hydrogen Gas and Steam	Rapid generation of hydrogen gas
Solid-state circuitry	5,051,695	Thin Film Vector Magnetometer	Magnetic field detection
Batteries	73,630	Cathod Material for a Thermal Battery	Synthetic pure iron disulfide material for cathodes in molten salt batteries
Electronics testing	5,021,738	Field, Variable, Electronically Controlled, Nested Coil Eddy Current Probe	Potential use in materials science whenever eddy current testing of materials is accomplished
Surveying	5,030,957	Method of Simultaneously Measuring Orthometric and Geometric Heights	Possibly oil exploration and geological surveying
Bomb squads	5,036,588	Nonvolatile, Fast-Response Wire Cutter	Use in demolition and bomb squads
Testing and measurement	5,045,695	Transition Radiation Interference Spectrometer	Use in high-power technology, perhaps future electrical power production
Space	5,051,751	Method of Kalman Filtering for Estimating the Position and Velocity of a Tracked Object	Air control and aerospace
Chemicals	4,956,168	Synthesis of Hydroxylamine Salts	Chemical production, manufacture of oxydizers

APPENDIX B

NAVSWC FY91 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Alarm systems	4,962,371	CPS Alarm System	Possible space station technology in out years
Infrared	4,962,303	Infrared Detector Array	Heat-sensitive manufacturing processes space development, broad spectrum application
Demolition	4,967,665	RF and DC Desensitized Electroexplosive Device	All electric explosive devices, blasting and demolition
Surveying	72,764	Method of Steering the Gain of a Multiple Antenna Global Positioning System Receiver	Surveying/positioning operations in E.M. environments—such as near airports
Electronics	4,996,972	Hot Air Heat Gun	Any environment requiring spark-free heat source such as shipyards, aircraft maintenance spaces, aerospace
Space	5,071,087	Method of Guiding an In-Flight Vehicle to a Desired Flight Path	Aerospace air control
Optics	72,845	Optical System for Linearizing Nonlinear Electro-Optic and Magneto-Optic Effects	Optical systems
Metallurgy	4,965,655	Corrosion Resistant Metallic Glass Coatings	Protecting steels from corrosion, particularly stainless steel used in highly corrosive environments such as SO_2 scrubbers

APPENDIX C

NAVSWC FY91 TECHNOLOGY APPLICATION ASSESSMENTS

Title	Lab No.
Laser Discrimination	NSWC-TAA-91-001
Optical Protection from Lasers	NSWC-TAA-91-002
Liquid Level & Volume Sensor	NSWC-TAA-91-003
Mullite Whiskers and Felt	NSWC-TAA-91-004
Electro-optic Voltage Sensor	NSWC-TAA-91-005
"SkinHeat"—Program to Calculate IR Parameters	NSWC-TAA-91-006

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name LASER DISCRIMINATION

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 16 JANUARY 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-001
D. Descriptors:
Detector
Laser
Infrared

E. Applications:
Detection of UV, near- and far-infrared lasers.
Discrimination of UV, near- and far-infrared lasers.
Laser safety goggles.

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? A single, inexpensive, room temperature detection device has unique characteristics for detecting and identifying ultraviolet, near- and far-infrared lasers. Detector material exhibits color-specific stimulated luminescence in relation to incident radiation wavelengths.

9. Other Uses: Laser goggles

10. Main Advantages: See Item 8.

11. Production Information: Suitable materials have been identified and prepared.

12. Descriptive Literature: U.S. Patent #4,947,465; "Stimulated Luminescence in Rare Earth Doped MgS," K. Chakrabarti, V. K. Arthur, J. F. Rhodes, and R. J. Abbundi; *Journal of Applied Physics 64*, 1363 (1988); "Evidence of v- centers in Rare Earth Doped MgS," K. Chakrabarti, V. K. Arthur, L. A. Thomas, and R. J. Abbundi, *Physics Review B38*, 10894 (1988); "Infrared-to-Visible Conversion Following Sub-Band-Gap Excitation in MgS: Eu," Sm. K. Chakrabarti, V. K. Arthur, and R. J. Abbundi, *Physics Review B39*, 10406 (1989).

13a. Literature Available From: V. K. Mathur (301) 394-1566 and K. Chakrabarti (301) 394-5102
Naval Surface Warfare Center (Code R41)
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

A new method for identifying unknown sources of laser light using optically stimulated phosphors is advanced in a recent patent from the Naval Surface Warfare Center. The technology is based on the use of a single doubly doped magnesium sulfide phosphor that is thermally/optically stimulated to generate a color correlatable to the incident laser radiation.

The phosphor, after being charged by ultraviolet light, exhibits stimulated luminescence in a green color when exposed to a near-infrared source (Nd:YAG laser). The same phosphor, however, emits an orange-red color for mid- to far-infrared sources (CO_2 laser). Exposure to an ultraviolet laser produces luminescence, which is of orange-red color but with a temporal profile similar to the laser.

A device using this phosphor is useful for detecting long wavelength infrared lasers. The technology is also capable of infrared laser diode beam profile analysis since this radiation source leaves an imprint on the phosphor that can be photographed. Continued development of the technology offers potential for laser communications and optical signal processing applications.

Suitable detector materials have been identified and prepared as illustrated by Figures 1 and 2.

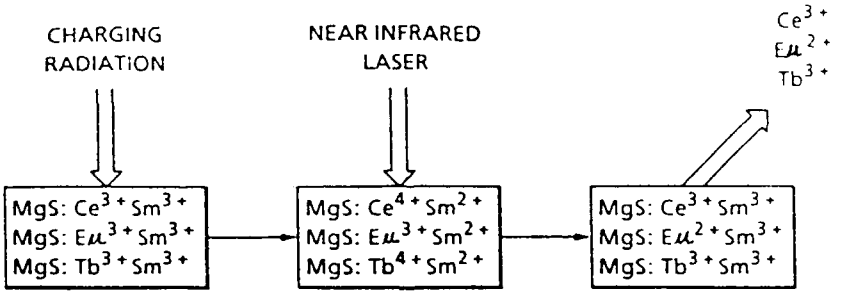


FIGURE 1. DISCRIMINATION OF A NEAR-INFRARED LASER

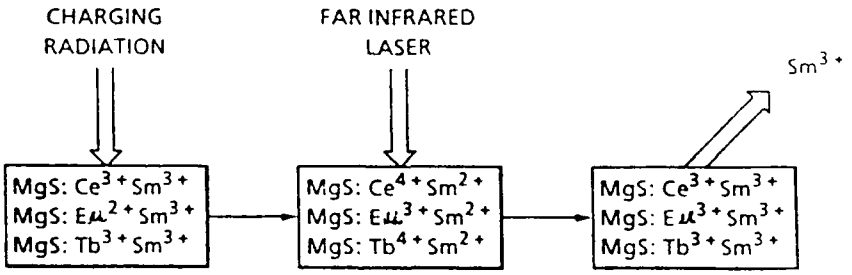


FIGURE 2. DISCRIMINATION OF A FAR-INFRARED LASER

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name OPTICAL PROTECTION FROM LASERS

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 14 FEBRUARY 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-002
D. Descriptors:
Filter
Laser
Protection

E. Applications:
Protection for eyes/equipment against laser sources, including devices with changeable frequency (agile lasers). Can be incorporated into telescopes, binoculars, or optical equipment such as image intensifiers.

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Eye and equipment protection from high-intensity, frequency-agile lasers using a nonlinear optical material. Passive operation; no power source required. Permits unimpeded passage of normal intensity spectrum, but absorbs or changes high-intensity sources into a harmonic outside desired spectrum for subsequent filtering. Scene may be safely viewed while being illuminated with hostile laser energy.

9. Other Uses: Laser goggles, optical surveillance equipment

10. Main Advantages: See Item 8.

11. Production Information: Candidate materials identified for testing.

12. Descriptive Literature: U.S. Patent # 4,909,609, "Nonlinear Optical Protection Against Frequency Agile Lasers"

13a. Literature Available From: Ramsey D. Johnson, Code D4T, (301) 394-1505
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Nonlinear optical materials provide protection for eyes and light-sensitive equipment from laser energy but do not interrupt normal light energy to these receptors. The materials permit unimpeded passage of the normal intensity spectrum while either absorbing high-intensity sources or changing them into a harmonic outside of the desired spectrum where they are subsequently filtered. Optical elements focus the waist of the beam within a nonlinear frequency-doubling optical fiber element. The nonlinear elements produce a harmonic outside the visible spectrum and absorb the laser energy. Response time is in nanoseconds. In contrast to this approach for laser protection, other types of filters exclude a band of the spectrum being received, and shutters completely close off the input signal.

The invention may use more than one filter and is adaptable with lenses to construct a telescope, binoculars, or can be incorporated into such equipment as image intensifiers. A preferred form uses either fiberlike tubes containing a nonlinear optical fluid or solid polymer fibers that absorb high-intensity laser energy while passing the low-intensity spectrum. This device may employ an array of these optic fibers that facilitate matching with fiber array image intensifiers. Features of the invention include

- Completely passive operation, no power sources required
- Eye/equipment protection against incident laser radiation having changeable frequencies (frequency-agile lasers)
- Protection against laser energy without blocking normal viewing modes
- Safe user viewing of scenes while being illuminated with hostile laser energy

The Naval Surface Warfare Center is interested in collaborating on a Cooperative Research and Development Agreement to further develop this invention.

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name LIQUID LEVEL & VOLUME SENSOR

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 11 MARCH 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-003
D. Descriptors:
Sensor
Liquid level
Liquid volume
Fiber optics

E. Applications:
Noncontact, noncontaminating optical attenuation method of liquid level or volume measurements for small (beakers, test tubes) or large translucent containers. Applicable to transparent or translucent fluids.

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Noncontact, noncontamination method of measuring level and volume of transparent/translucent fluid in a container. Optical attenuation technique for accurate, continuous measurement ability (from empty to full) for beakers and test tubes with a single sensor.

9. Other Uses: Medical and chemical laboratories; production lines for filling liquid containers.

10. Main Advantages: Noncontact/noncontaminating, accurate, single sensor, low technical risk

11. Production Information: Off-the-shelf equipment and parts, low technical risk, requires limited manufacturing resources.

12. Descriptive Literature: U. S. Patent # 561,413, "Liquid Level and Volume Measurement Device"

13a. Literature Available From: Ramsey D. Johnson, Code D4T, (301) 394-1505
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

This device utilizes an optical attenuation technique to measure liquid levels and volumes without contaminating the liquid under observation. It provides an accurate, extended measurement range (from empty to full)–without contacting either the fluid or its container–via a single light source, detector, and associated electronics. The device is applicable to transparent and translucent fluids in containers of similar optical transmission characteristics. Figure 1 is a schematic diagram of the device.

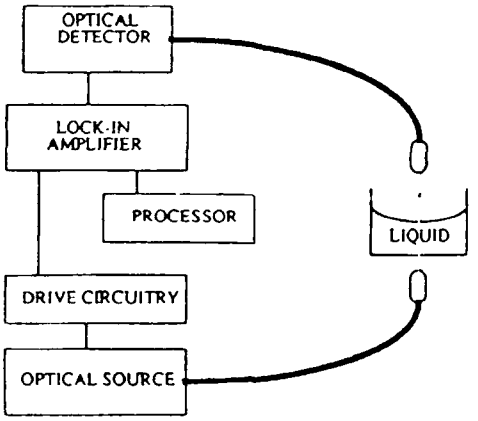


FIGURE 1. SCHEMATIC OF LIQUID LEVEL AND VOLUME SENSOR

The function of the optical source is to emit a constant output within a specific wavelength band. Examples are white source with appropriate filters or monochrometer or a laser diode. The source wavelength is chosen to match the spectral properties of the fluid to be measured. Sources are commercially available to match absorption characteristics of most fluids, including the 1300 nanometers required for water-based fluid measurements. The source may be used direct, through a lens, or remotely located from the measurement area by coupling into an optical fiber. The detector can be similarly configured. Analysis circuitry used to convert detector output to liquid level or volume measurements is comprised of standard off-the-shelf components. It processes the detector output to determine the attenuation of the optical beam for subsequent correlation to the parametric measurements. Features of the device include

- Noncontact/noncontaminating technique for liquid volume and level measurements
- Single sensor for accurate, continuous measurements (empty to full range)
- Low technical risk
- Off-the-shelf equipment and parts

Potential users of this device include medical and chemical laboratories and manufacturing facilities having production lines for filling liquid containers.

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name MULLITE WHISKERS AND FELT

5. Technology Type: ((a)) Process (b) Apparatus ((c)) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government (b) State Government (c) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry (g) Consultant (h) Other: _____

A. Date: 8 APRIL 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-004
D. Descriptors:
Mullite whiskers
Mullite whisker felt
Composites
Manufacturing process

E. Applications:
Manufacture of composites (polymers, metals, ceramics)
Thermal insulation
High-temperature filters
Heat exchangers

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Processes for the economic manufacture of mullite whiskers and mullite whisker felt as reinforcement material for advanced polymer-, metal-, and ceramic-matrix composites. Resulting features include oxidation resistance, low thermal expansion, low dielectric constant, near-net shape forms, and retention of strength at high temperature. Also, whiskers are formed in-situ during firing, thus health hazards associated with handling loose whiskers are eliminated.

9. Other Uses: The rigid felt itself has potential as high-temperature thermal insulation, catalysts supports, and filters.

10. Main Advantages: Oxidation resistant composites. Fabricated composite shapes require less machining (small dimensional change between green preform and final fixed shape permits near-net shape composite objects). See Item 8.

11. Production Information: Process repeatedly demonstrated in laboratory. Scalable to larger operations.

12. Descriptive Literature: See Item 13b.

13a. Literature Available From: Inna G. Talmy, (301) 394-2268, and Deborah A. Haught, (301) 394-2268
Naval Surface Warfare Center (Code R31)
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

The Naval Surface Warfare Center has developed and patented processes for the economic manufacture of mullite whiskers and 80-percent mullite whisker felt to be used in preparation of advanced polymer-, metal-, and ceramic-matrix composites. The rigid felt itself has potential for applications such as high-temperature thermal insulation, catalyst supports, and filters. Mullite ($3Al_2O_3$ $2SiO_2$) has good retention of strength at high temperatures, a low thermal expansion coefficient, and a low dielectric constant and loss tangent. An important advantage of mullite whiskers compared with nonoxide whiskers, such as silicon carbide, is that they can be used in an oxidizing environment at high temperatures as well as in electronic ceramics.

The felt consists of randomly oriented stoichiometric mullite whiskers that are mutually intergrown forming a rigid structure. A significant aspect of the felt preparation process is that there are no whiskers in the precursor mixture. The whiskers are formed in-situ during the firing step. Loose whiskers are not handled at any step of the process, thus health hazards associated with handling loose whiskers are eliminated. Another important feature is that the dimensional change between the green preform and the final fired shaped felt is low, about 1-percent expansion. This makes possible the fabrication of near-net shape preforms for composites that will require minimum machining.

REFERENCES

U. S. Patent #4,910,172, "Preparation of Mullite Whiskers from AlF_3, SiO_2, and Al_2O_3 Powders"

U. S. Patent #4,911,902, "Mullite Whisker Preparation"

U. S. Patent #4,948,766, "Rigid Mullite Whisker Felt and Method of Preparation"

Talmy, Inna G., and Haught, Deborah A., "Preparation of Mullite Whiskers," Fiber-Tex 87 Conference, NASA Conference Publication 3001, pp. 69-78, November 1987.

Talmy, Inna G., and Haught, Deborah A., "Preparation and Properties of Rigid Mullite-Whisker Felt," *Proceedings of 12th Conference on Composite Materials and Structure*, NASA Conference Publication 3018, pp. 1-11, January 1988.

Talmy, Inna G., and Haught, Deborah A., "Mullite Whisker Felt Preparation and Properties," *Navy Materials and Structures Bulletin*, Vol. XXII, No. 1, April 1988.

Talmy, Inna G., and Haught, Deborah A., "Preparation of Mullite Whiskers," *Navy Materials and Structures Bulletin*, Vol. XXII, No. 1, April 1988.

Talmy, Inna G., Haught, Deborah A., and Limaye, S., (Ceramatec), "Porous Mullite Whisker Felt for Preshaped Composite Preforms," *Materials and Processing Report*, Vol. 4, No. 7, 1989.

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name ELECTRO-OPTIC VOLTAGE SENSOR

5. Technology Type: ((a)) Process ((b)) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government (b) State Government (c) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry (g) Consultant (h) Other: _____

A. Date: 16 MAY 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-005
D. Descriptors:
Electro-optic, Sensors, Birefringence, Pockels Cell, Pockels Effect, Faraday Effect, Faraday Rotator, Transducer

E. Applications:
This method increases the linear range for rapidly measuring voltages by electro-optic or magneto-optic means, specifically Pockels Cells and Faraday Rotators.

7. Potential Support: ((exclusive license)) ((consulting)) ((joint venture)) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? The outputs of two nonlinear transducers are superimposed to provide a more linear output than a single nonlinear transducer for measuring voltages. This is achieved with no degradation in response time.

9. Other Uses: N/A

10. Main Advantages: Less complex than other methods to extend the linear range of electro-optic sensors. Maintains fast response time of a single transducer. Method is totally optical (photonic).

11. Production Information: Components are commerically available. Products of companies presently manufacturing electro-optic transducers are readily adaptable to this technique.

12. Descriptive Literature: Patent Application–"Optical System for Linearizing Non-Linear Electro-Optic and Magneto-Optic Effects"

13a. Literature Available From: J. Keith Pillow, Code F45, (703) 663-8057
Naval Surface Warfare Center
Dahlgren Division
Dahlgren, VA 22448-5000

13b. Description:

The Naval Surface Warfare Center has developed a device (patent pending) for rapidly measuring voltages by electro-optic or magneto-optic means. It provides a key feature of exhibiting a substantially linear response over much of its operating range. The device employs the Pockels effect in which the orientation of polarized light is altered in direct response to applied voltages. The response of the device is made substantially more linear by dividing the polarized light into two beams and retarding the phase of the second beam by one-quarter wavelength, attenuating its intensity by a factor of approximately four, and passing it through a second Pockels cell having a transducer constant of one half that of the first Pockels cell. The two beams are then recombined, or superpositioned, thus yielding a substantially linear response over much of the applied voltage range.

The degree of linearization is shown in Figure 1. The figure also shows that the linearization process attenuates the intensity signal; however, this limitation can be overcome by using a more powerful laser or a more sensitive detector. An important factor is that this method not only applies to traditional Pockels cell arrangements but also to Faraday rotators, and in general, any electro-optic/magneto-optic transducer that has a response function varying as the square of the sine of a stimulus.

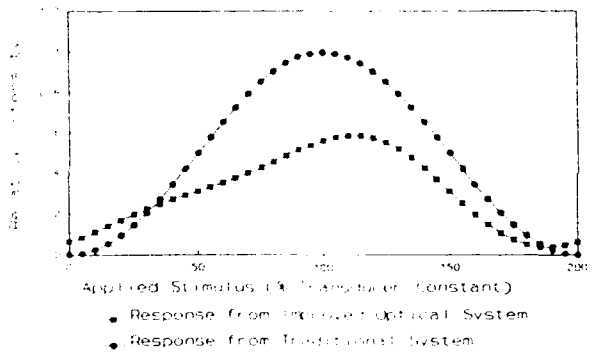


FIGURE 1. TRANSFER FUNCTION COMPARISON

Applications: Traditional B-field and E-field probes, although having a broad bandwidth, are frequency dependent in response. Electro-optic/magneto-optic transducers could be a feasible replacement for these traditional probes where high fields are involved. Such transducers do not have a high frequency dependence and have a broad bandwidth as well. Unfortunately, today's electro-optic/magneto-optic transducers have a limited linear range and therefore require significant analysis of the transducer output to obtain information. If the linear range of the transducer is increased by using this method, such electro-optic/magneto-optic transducers could find wide acceptance as replacements for present diagnostics. High-voltage and high-current diagnostics that offer high-bandwidth, high-impedance or inert characteristics and significant linear-range could find applicability in the power-producing industry, as well as many defense-related industries and research activities.

TECHNOLOGY APPLICATION

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name SKINHEAT

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Software

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 10 JULY 1991
B. CUFT #: _____
C. LAB #: NSWC-TAA-91-006
D. Descriptors:
Aerodynamic skin heating, black body radiometric, Macintosh program

E. Applications:
Computer program for calculating aerodynamic skin heating and radiometric parameters of supersonic targets, Applicable to performance assessment of infrared search and track equipment.

7. Potential Support: exclusive license, (consulting) joint venture, drawings, tooling, (computer prog.), economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? This software program called "SkinHeat" calculates aerodynamic skin heating of supersonic targets for various conditions and, conversely, calculates radiometric parameters for an object having a given skin temperature. It integrates the Planck Function and can also solve for what black body or grey body temperature is needed to provide a given radiance level. It calculates irradiance of a black body or grey body for a given range.

9. Other Uses: N/A

10. Main Advantages: Extremely fast, accurate, and easy to use. Combines several related computations into one user friendly graphical interface. Programmed for a Macintosh II computer.

11. Production Information: Copies can be produced on Macintosh formatted 3.5-in. diskettes.

12. Descriptive Literature: Release notes provided on diskette with "SkinHeat" program and commented Pascal source code.

13a. Literature Available From: Stephen B. Rogers, Code G21, (703) 663-7291
Naval Surface Warfare Center
Dahlgren Division
Dahlgren, VA 22448-5000

13b. Description:

"SkinHeat" is an infrared calculator utility program for a Macintosh II computer (68020/68030 CPU) with a floating point coprocessor (68881/68882 FPU). The program will

- Calculate target aerodynamic skin heating temperature using target speed, airflow conditions, and ambient air temperature
- Calculate radiant emittance and radiant intensity using skin temperature, target emissivity, target area, and spectral band
- Calculate target irradiance (ignoring atmospheric effects) given a range to the target in kilometers
- Backwards calculate any single missing input as a solution given a set of related parameters

All parameters are visible and accessible at any time. All parameters can be solved for, but only one dependent variable at a time may be addressed. Figure 1 shows the user interface that displays the values and allows them to be edited.

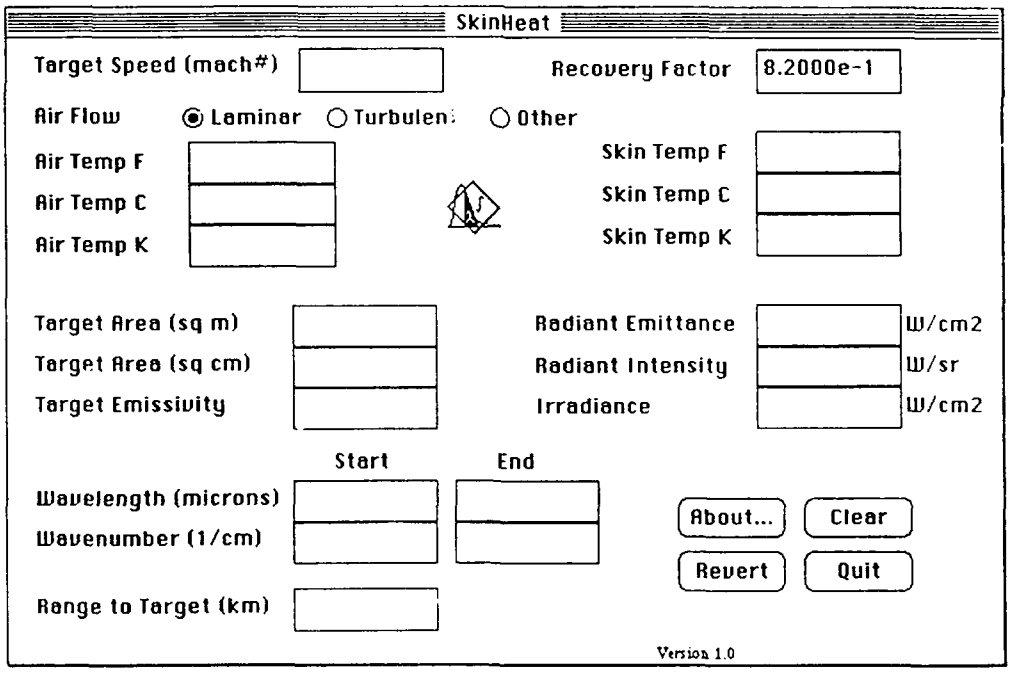


FIGURE 1. SKINHEAT USER INTERFACE

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13. ABSTRACT *(Maximum 200 words)*

This report summarizes Naval Surface Warfare Center (NAVSWC) participation in the following five principal areas involving technology interactions with the public and private sectors: (1) Domestic Technology Transfer (DTT), (2) Navy Potential Contractor Program (NPCP), (3) Industry Independent Research & Development (IR&D), (4) Small Business Innovation Research (SBIR), and (5) Science and Technology Contracting.

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